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LOUDSPEAKING TELEPHONE DEVICE

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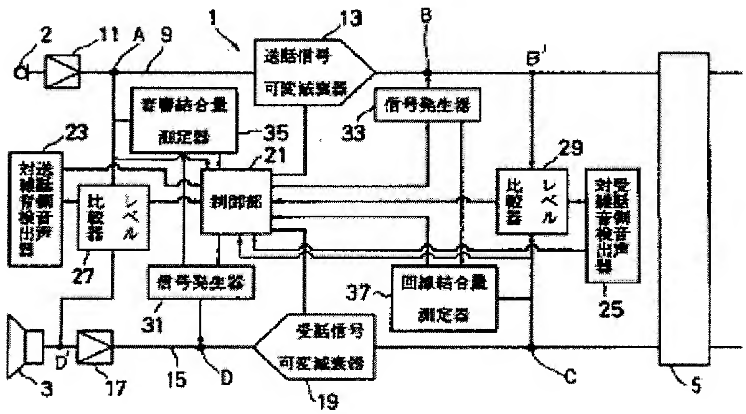
Abstract

Objective

To provide a loudspeaking telephone device wherein the amount of attenuation of the transmission signal and the reception signal can be set correctly and easily according to the amount of line coupling produced by the connection state to the line, as well as the acoustic coupling produced by the installation environment and usage circumstances, in order to permit reliable conversation without diminished naturalness.

Constitution

A signal (white noise, for example) to measure the amount of coupling from signal generator 33 to transmission signal path 9, and from signal generator 31 to reception signal path 15 is output with a command from control part 21, acoustic coupling meter 35 and line coupling meter 37 calculate their respective acoustic coupling amount and line coupling amount based on the detection level difference of the signal between the receiving side and transmission side, and control part 21 sets the sum of the amount of attenuation of transmission signal variable attenuator 13 and reception signal variable attenuator 19 based on the calculated result.



Key: 13 Transmission signal variable attenuator
19 Reception signal variable attenuator
21 Control part
23 Transmission side voice to noise sensor
25 Reception side voice to noise sensor
27 Level comparator
29 Level comparator
31 Signal generator
33 Signal generator
35 Acoustic coupling meter
37 Line coupling meter

Claims

1. A loudspeaking telephone device that transmits a transmission signal input from a microphone to a line part through a transmission signal path and also outputs a reception signal output from the aforementioned line part through a reception signal path to a speaker, characterized by comprising: a transmission signal variable attenuator that attenuates the transmission signal input to the aforementioned transmission signal path from the aforementioned microphone, a reception signal variable attenuator that attenuates the reception signal input from the aforementioned line part to the aforementioned reception signal path, and a control means that controls the aforementioned transmission signal variable attenuator and the aforementioned reception signal variable attenuator while maintaining the relative relationship of the two; a loudspeaking telephone device provided with: a line coupling amount measurement means that measures the amount of line coupling from the aforementioned transmission signal path through the aforementioned line part to the aforementioned reception signal path, an acoustic coupling amount measurement means that measures the amount of acoustic coupling from a speaker to the microphone in the environment in which the aforementioned speaker and microphone are installed, and a gain setting means that sets the sum of the amount of attenuation of the aforementioned

transmission signal variable attenuator and the amount of attenuation of the aforementioned reception signal variable attenuator, based on the measured output of the aforementioned line coupling amount measurement means and the aforementioned acoustic coupling amount measurement means, and transmits said setting value to the aforementioned control means at a point when a call has not been started.

2. The loudspeaking telephone device described in Claim 1, characterized by comprising a first signal generator connected to the aforementioned reception signal path, where the aforementioned acoustic coupling amount measurement means calculates the difference in signal level of the signal output to the aforementioned reception signal path from the aforementioned first signal generator detected in the aforementioned transmission signal path, relative to the signal level detected in the aforementioned reception signal path, and measures the amount of acoustic coupling based on the result.

3. The loudspeaking telephone device described in Claim 1, characterized by comprising a second signal generator connected to the aforementioned transmission signal path, where the aforementioned line coupling amount measurement means calculates the difference in the signal level of the signal output to the transmission signal path from the aforementioned second signal generator detected in the aforementioned reception signal path, relative to the signal level detected in the aforementioned transmission signal path, and measures the amount of line coupling based on the result.

4. The loudspeaking telephone device described in Claim 2 or 3, wherein the signals generated from the aforementioned first and second signal generators comprise a frequency component required for the call transmission band.

5. The loudspeaking telephone device described in Claim 2 or 3, wherein the signals generated from the aforementioned first and second signal generators are band noise.

6. The loudspeaking telephone device described in Claim 2 or 3, wherein the signals generated from the aforementioned first and second signal generators are white noise.

7. The loudspeaking telephone device described in Claim 2 or 3, wherein the signals generated from the aforementioned first and second signal generators are a pure tone.

Detailed explanation of the invention

[0001]

Industrial application field

The present invention relates to a hands-free telephone, telephone conference system or other loudspeaking telephone device. Specifically, it relates to a loudspeaking telephone device connected to a telephone, conference system or other line and can switch audio according to the level of the signals sent and received.

[0002]

Prior art

When loudspeaking is provided using a speaker and microphone in a loudspeaking telephone device, the amount of return, which represents the ratio at which signals input to the circuit are returned to the line from loop gain and the line in the loudspeaking telephone device, must be small in order to prevent howling. For this reason, hands-free circuits are used to complementarily control the amount of attenuation of a transmission signal variable attenuator and a reception signal variable attenuator furnished, respectively, in the transmission signal path wherein transmission signals are transmitted to a telephone line and a reception signal path wherein reception signals are transmitted to a speaker. Examples of conventional hands-free circuits are shown in Figure 2 and Figure 3. Figure 2 is a block diagram of a hands-free circuit disclosed in Japanese Kokoku Patent No. Hei 4[1992]-50786. In the figure, a transmission audio signal produced by a near-end talker is input to microphone 102 of telephone 101. The audio signal input to microphone 102 is amplified by microphone amp 103, passes through transmission signal variable attenuator 105 and amplifier 107, and is output to the telephone line through a hybrid transformer from output terminal 109. The reception signal output from the far-end talker's side over the telephone line enters telephone 101 through a hybrid transformer from input terminal 111, passes through amplifier 113, reception signal variable attenuator 115 and speaker amp 117, is output by speaker 119, and reaches the near-end talker.

[0003]

Here, the amount of attenuation of transmission signal variable attenuator 105 and the amount of attenuation of reception signal variable attenuator 115 is controlled with a control part 120 based on the volume of the transmission signal and the reception signal. That is, the transmission signal level and the reception signal level are compared with comparators 121 and 123. Whether there is audio in the transmission signal is sensed with a signal to noise sensor 127, and whether there is audio in the reception signal with a signal to noise sensor 125. Control part 120 determines which mode should be used, e.g., transmission mode, reception mode, or fast or slow idle mode, depending on the output signals from comparators 121 and 123 and signal to noise sensors 125 and 127, and, depending on them, determines the amount of attenuation of transmission signal variable attenuator 105 and the amount of attenuation of reception signal variable attenuator 115. The amount of attenuation of transmission signal variable attenuator 105 and the amount of attenuation of reception signal variable attenuator 115 are controlled complementarily, that is, they are controlled while kept in a complementary relationship so that the sum of the amount of attenuation of the two is constant. When the transmission signal level in both

comparators 121 and 123 is greater than the reception signal level, and audio is sensed by signal to noise sensor 127, transmission mode starts, the amount of attenuation of transmission signal variable attenuator 105 is set to the minimum, and the amount of attenuation of reception signal variable attenuator 115 is set to the maximum. When the reception signal level in both comparators 121 and 123 is greater than the transmission signal level, and audio is sensed by signal to noise sensor 125, reception mode starts, the amount of attenuation of transmission signal variable attenuator 105 is set to the maximum, and the amount of attenuation of reception signal variable attenuator 115 is set to the minimum. When no audio is sensed in both the transmission signal and the reception signal, slow idle mode starts. When the comparison result of the transmission and reception signal levels in comparators 121 and 123 shows disparity, and at least either signal to noise sensor 125 or 127 senses audio, fast idle mode starts, and the amount of attenuation of transmission signal variable attenuator 105 and reception signal variable attenuator 115 are both set to medium level. In either mode, reliable communication without howling is enabled by keeping the sum of the amount of attenuation of transmission signal variable attenuator 105 and the amount of attenuation of reception signal variable attenuator 115 at a constant value.

[0004]

Figure 3 is a configuration example of a conventional hands-free circuit disclosed in US Patent No. 3952166. In the figure, a transmission audio signal from the near-end talker is input to microphone 203 of telephone 201. The audio signal input to microphone 203 is amplified by microphone amp 205, passes through transmission signal variable attenuator 207, and is output to the telephone line from output terminal 209 through a hybrid transformer. A reception signal is output through the telephone line from the far-end talker's telephone enters telephone 201 from input terminal 211 through a hybrid transformer, passes through reception signal variable attenuator 213 and speaker amp 215, is output from speaker 217, and reaches the near-end talker. Here, the amount of attenuation of transmission signal variable attenuator 207 and the amount of attenuation of reception signal variable attenuator 213 are controlled complementarily according to the magnitude of the transmission signal and the reception signal in the same way as in the conventional example in Figure 2, and the call audio during a call is used to measure the acoustic coupling amount and the line coupling amount. That is, during transmission while the near-end talker is talking, the line coupling amount is measured by sensing the audio signal level in the reception signal path relative to the audio signal level in the transmission signal path, and when less than the initial line coupling amount, the amount of attenuation of reception signal variable attenuator 213 is decreased by that amount. During reception when the far-side speaker is talking, the acoustic coupling amount is measured by sensing the audio signal level in the transmission signal path relative to the audio signal level in the reception signal path, and when smaller than the

acoustic coupling amount set initially, the amount of attenuation of transmission signal variable attenuator 207 is changed to decrease by that amount. The amount of attenuation of transmission signal variable attenuator 207 and reception signal variable attenuator 213 can be adjusted appropriately according to the environment in which the loudspeaking telephone device is placed by performing this operation continuously during a call. The howling margin in the hands-free circuit becoming unnecessarily large is avoided, the amount of change in the attenuation amount of transmission signal variable attenuator 207 and reception signal variable attenuator 213 is reduced a small amount, and simultaneous two-way calling capability can be improved.

[0005]

Problems to be solved by the invention

The line coupling amount may then change according to the line to which the loudspeaking telephone device is connected, and the acoustic coupling amount may change according to the environment or usage conditions where the speaker and microphone are installed. For this reason, in the case of the former of the two conventional examples above, the line coupling amount and the acoustic coupling amount used to determine the sum of the amount of attenuation of the transmission signal variable attenuator and the amount of attenuation of the reception signal variable attenuator must assume in advance a state close to the maximum of these coupling values, so the sum of the amount of attenuation of the transmission signal variable attenuator and the amount of attenuation of the reception signal variable attenuator is often determined to be greater than necessary. When the sum of the amount of attenuation of the transmission signal variable attenuator and the amount of attenuation of the reception signal variable attenuator is set greater than necessary, in this way, the change in the amount of attenuation of the variable attenuators when switching between transmission and reception will be larger, and the beginning or ending of speech is easily cut off. And while a first person is talking, if another person cuts in to talk, since the amount of attenuation of the reception signal variable attenuator inserted in the reception signal path is larger, the voice of the aforementioned other person will not be heard at all by the aforementioned first person or only with difficulty. That is, simultaneous two-way calling capability is low, and natural conversation is diminished. And in the case of the latter conventional example above, the acoustic coupling amount and the line coupling amount are measured constantly during a call, and the amount of attenuation of the transmission or reception signal variable attenuator during a call is adjusted to the optimal state for the environment in which loudspeaking telephone device is placed by changing the amount of attenuation of the transmit or reception signal variable attenuator accordingly. In order to constantly measure the acoustic coupling amount and the line coupling amount during a call, and to adjust the amount of attenuation of the transmission signal variable attenuator or the reception signal variable attenuator

accordingly, the circuit configuration must be complicated, the amount of calculation increases, and the cost of the device is higher. Furthermore, when the near-end talker moves during reception and the acoustic coupling amount changes, the amount of attenuation given to the transmission signal changes accordingly, so particularly in the case of loud noise around the near-end talker, the level of noise that the far-end talker hears from the receiver varies, giving the sense of an unreliable, unnatural conversation. The present invention was conceived in consideration of this situation, and provides a loudspeaking telephone device with which the amount of attenuation of the transmission signal and the reception signal can be set accurately and easily corresponding to the line coupling amount produced by the coupling circumstances to the line, and the acoustic coupling amount produced by the installation environment or usage circumstances, and with which reliable conversation can be accomplished without naturalness being diminished.

[0006]

Means to solve the problems

In order to solve the problems described above, the present invention is a loudspeaking telephone device that outputs a transmission signal input from a microphone to a line through a transmission signal path, and also outputs a reception signal input from the aforementioned line part to a speaker through a reception signal part, and is constituted as a loudspeaking telephone device characterized by comprising a transmission signal variable attenuator that attenuates the transmission signal input to the aforementioned transmission signal path from the aforementioned microphone, a reception signal variable attenuator that attenuates the reception signal input to the aforementioned reception signal path from the aforementioned line part, and a control means that controls the aforementioned transmission signal variable attenuator and the aforementioned reception signal variable attenuator while maintaining the complementary relationship of the two, there are provided: a line coupling amount measurement means that measures the amount of line coupling from the aforementioned transmission signal path through the aforementioned line part to the aforementioned signal receive path, an acoustic coupling amount measurement means that measures the amount of acoustic coupling from the speaker to the microphone, and a gain setting means that sets the sum of the amount of attenuation of the aforementioned transmission signal variable attenuator and the amount of attenuation of the aforementioned reception signal variable attenuator based on the measured output of the aforementioned line coupling amount measurement means and the aforementioned acoustic coupling amount measurement means, and that sends the aforementioned setting value to the aforementioned control means at a point at which a call has not yet been started. The aforementioned loudspeaking telephone device can be constituted to comprise a first signal generator connected to the aforementioned reception signal path, and such that the aforementioned acoustic coupling amount measurement means calculates the difference in

the signal level of the signal output into the aforementioned reception signal path from the aforementioned first signal generator sensed in the aforementioned transmission signal path, relative to the signal level sensed in the aforementioned reception signal path, and measures the amount of acoustic coupling based on the result.

[0007]

The aforementioned loudspeaking telephone device can also be constituted to comprise a second signal generator connected to the aforementioned transmission signal path, and such that the aforementioned line coupling amount measurement means calculates the difference in the signal level of the signal output into the transmission signal path form the aforementioned second signal generator sensed in the aforementioned reception signal path, relative to the signal level sensed in the aforementioned transmission signal path, and measures the amount of line coupling based on the result. In this case, the signals generated from the aforementioned first and second signal generators can be constituted as signals that include a frequency component required for the call transmission band. The signals generated from the aforementioned first and second signal generators can also be composed of band noise. In addition, the signals generated from the aforementioned first and second signal generators can also be composed of white noise. In addition, the signals generated from the aforementioned first and second signal generators can also be composed of a pure tone.

[0008]

Operation

With the loudspeaking telephone device of the present invention, the amount of line coupling and the amount of acoustic coupling are automatically measured by outputting signals from signal generators to the transmission signal path and the reception signal path, and the sum of the amount of attenuation of the reception signal variable attenuator and the amount of attenuation of the transmission signal variable attenuator is set using the amount of line coupling and the amount of acoustic coupling measured in the actual usage environment of the loudspeaking telephone device. So the amount of attenuation can be set according to usage conditions in order to obtain the desired howling margin, and the sum of the amount of attenuation of the transmission signal variable attenuator of the reception signal variable attenuator will not be set greater than necessary. Therefore, the change in the amount of attenuation when switching between transmission and reception will be relatively small, the beginning and end of speech is not easily cut off, and natural conversation is accomplished. Furthermore, because setting of the sum of the amount of attenuation of the transmit variable attenuator and the receive variable attenuator corresponding to measurement of the amount of acoustic coupling and the amount of line coupling

is performed with appropriate timing when a call has not yet been started, complicated processing to measure the amount of acoustic coupling and the amount of line coupling and change the amount of attenuation accordingly during a call is not necessary, the amount of calculation can be reduced, and device assembly costs can be made inexpensive.

[0009]

Application example

Below, an application example of the present invention will be explained in detail based on figures. Figure 1 is a block diagram of a speakerphone (hands-free telephone) pertaining to an application example of the present invention. Speakerphone 1 has a microphone 2 that inputs transmission audio and a speaker 3 that outputs reception audio. Microphone 2 and speaker 3 each are connected through a hybrid transformer 5 to a telephone line (illustrated with a broken line). Transmission signal path 9 that connects microphone 2 and hybrid transformer 5 is provided with a microphone amp 11, transmission signal variable attenuator 13, and reception signal path 15 that connects speaker 3 and hybrid transformer 5 is provided with a speaker amp 17 and a reception signal variable attenuator 19. Speakerphone 1 is additionally provided with a control part 21, transmission side and reception side voice to noise sensors 23 and 25, level comparators 27 and 29, signal generators 31 and 33, an acoustic coupling meter 35, and a line coupling meter 37, to prevent howling during a loudspeaking call.

[0010]

"A transmission side signal variable attenuator that attenuates the transmission signal input from the microphone, a reception side signal variable attenuator that attenuates the reception signal input from the telephone line, and a control means that complementarily controls the amount of attenuation of the aforementioned transmission signal variable attenuator and the aforementioned reception signal variable attenuator," that is, a conventionally known "echo suppressor" is composed of the combination of voice to noise sensors 23 and 25, level comparators 27 and 29, and control part 21. Transmission side voice to noise sensor 23 determines for the signal at point A on the transmission signal path, and voice to noise sensor 25 for the signal at point C on the reception signal path, whether there is only background noise (audio signal with only moderately varying volume) or whether voice is included (audio signal with abrupt change in volume). Level comparators 27 and 29 sense whether the transmission side signal or the reception side signal is larger. Control part 21 performs reliable echo suppressor control with little malfunctioning by determining whether the state is transmission or reception according to the signals sent from these four units. Examples of other echo suppressor control methods follow:

1) a two-point sensing method wherein whether transmission or reception is determined just with a comparison of the levels of signals at 2 points, e.g., at point A and point C, at point A and point D', at point B' and point D', or at point B' and point C in Figure 1,

2) a three-point sensing method where, in addition to the comparison of levels between 2 points illustrated in 1) above, audio sensing of the signal at point A or point C is performed,

In each method, level comparators and voice to noise sensors as in this application example are used. A description follows of the actual operation of speakerphone 1 constituted as described above.

[0011]

(1) At initial setting (when power is turned on, or upon line connection), acoustic coupling GAC and line coupling GST are automatically measured by acoustic coupling meter 35 and line coupling meter 37. The acoustic environment and the line environment where the telephone is installed are recognized by control part 21 based on the measured values, and the sum of the maximum value and the minimum value for the attenuation amounts permissible for attenuators 13 and 19 is set from the howling margin requirement. The minimum value for the attenuation amount is also set from the requirement for reception gain from the line to speaker 3, and for transmission gain from microphone 2 to the line. The maximum value and minimum value for the amount of attenuation are determined as described next according to the calling conditions in transmission mode and reception mode, based on "a determination means for the sum of the amount of attenuation in aforementioned transmission signal variable attenuator 13 and the amount of attenuation in reception signal variable attenuator 19" described below. In this application example, the amounts of attenuation are determined based on the complementary relationship that will make the "sum" of the aforementioned amounts of attenuation constant, and the complementary relationship is controlled not only in "cases to make the sum of the two constant" described above, but also so that the sum of the two amounts of attenuation do not exceed a constant value. For example, it is conceivable that, in a transmission state, the amount of attenuation of transmission signal variable attenuator 13 is set to the maximum, and the amount of attenuation of the reception signal variable attenuator is set to the minimum; in a reception state, the amount of attenuation of transmission signal variable attenuator 13 is set to the maximum, and the amount of attenuation of the reception signal variable attenuator is set to the maximum; in other states (such as when both talkers are silent), the amount of attenuation of both variable attenuators is set to the maximum.

(2) When a call is started, a transmission state, a reception state or a no-audio state is distinguished by control part 21 based on the sensed values from comparators 27 and 29.

[0012]

① If a transmission state, transmission attenuator 13 is kept at the minimum amount of attenuation and reception attenuator 19 is kept at the maximum amount of attenuation by control part 21. In this application example, the minimum amount of attenuation of aforementioned transmission attenuator 13, and the maximum amount of attenuation of reception attenuator 19 are kept in a complementary relationship so that their sum will be a specific constant value.

② If a reception state, transmission attenuator 13 is kept at the maximum amount of attenuation and reception attenuator 19 is kept at the minimum amount of attenuation by control part 21. In this case, too, the maximum amount of attenuation of aforementioned transmission attenuator 13, and the minimum amount of attenuation of reception attenuator 19 are kept in a complementary relationship so that their sum will be a specific constant value.

③ If a no-audio state, the previous state is held for the amount of attenuation of each.

Two comparators are furnished in this application example, but when a digital circuit is used, only one comparator may be provided to compare the inputs of transmission attenuator 13 and reception attenuator 19, since the amount of attenuation of transmit/reception attenuators 13 and 19 is known in advance. The amount of attenuation of attenuators 13 and 19 is set with an initial setting, but when the external volume of the speaker amp is changed while in use, for example, the amount of attenuation may be reset in response to the volume change.

[0013]

To "complementarily control the amount of attenuation of the transmission signal variable attenuator and the reception signal variable attenuator" in this way, the "details of complementarily controlling" are important. For example, when a complementary relationship is maintained such that the sum of the amount of attenuation of the transmission signal variable attenuator and the reception signal variable attenuator is constant as described above, how the aforementioned sum is set to what value is important, and how it is determined for a sufficient value necessary for the actual situation, or is set namely so that disadvantages produced by unnaturalness in the conversation are avoided, is important. With an echo suppressor of the hands-free circuit type without the function shown below, which is a feature of this application example, variation in the environment where the telephone is placed is taken into consideration in the design to ensure that howling will not occur. The sum of the two variable attenuators 13 and 19 is greater than necessary, the beginning and end of speech are readily cut off, simultaneous two-way calling capability decreases, and the risk of conversion being unnatural is great. So, with this application example, by correctly determining the sum of the amount of attenuation of transmission signal variable attenuator 13 and reception signal variable attenuator 19 according to the environment where speakerphone 1 is placed, just the minimum unnaturalness required (if conditions are good, a call

that produces absolutely no sense of unnaturalness is also possible) is sufficient, and more natural conversation is enabled.

[0014]

Next, the technique for calculating the sum of the amount of attenuation of aforementioned transmission signal variable attenuator 13 and the amount of attenuation of reception signal variable attenuator 19 will be explained. When power to speakerphone 1 is turned on and it is connected to a telephone line, signal generator 33 sends a signal, for example, white noise, to measure the amount of line coupling to point B in transmission signal path 9, with a command from control part 21. This signal is output to the telephone line through hybrid transformer 5, and enters reception signal path 15 as a side tone due to line coupling. The amount of line coupling is found by line coupling meter 37 from the difference in the signal level sent to transmission signal path 9 and the signal level sensed in reception signal path 15. In the same way, signal generator 31 sends a signal, for example, white noise, to measure the amount of acoustic coupling to point D in reception signal path 15 with a command from control part 21. The signal is emitted as sound from speaker 3, some of which reaches microphone 2, and is output to transmission signal path 9. Acoustic coupling is found by acoustic coupling meter 35 from the signal level sent to reception signal path 15 and the signal level sensed in transmission signal path 9. Control part 21 determines the sum of the amount of attenuation of transmission signal variable attenuator 13 and the amount of attenuation of reception signal variable attenuator 19 from the measurement output from acoustic coupling meter 35 and line coupling meter 37, and the known gain of all portions in the hands-free circuit.

[0015]

In this case, there is the gain hands-free circuit microphone GMA (known), the amount of line coupling GST (unknown), gain GSA or speaker amp 17 (known), the amount of acoustic coupling GAC (unknown), other gain GT present in the transmission signal path (known), gain GHT that hybrid transformer 5 imparts to the transmission signal (known), gain GHR that hybrid transformer 5 imparts to the reception signal (known), the amount of return to line RL (known), other gain GR present in the reception signal path (known), and the desired howling margin HM (known). Using these values, the sum G of the amount of attenuation GTX (dB) of transmission signal variable attenuator 13 and the amount of attenuation (GRX) (dB) of reception signal variable attenuator 19 is determined to satisfy

$$G = GTX + GRX > HM + GMA + GT + GST + GR + GSA + GAC$$

$$G = GTX + GRX > -RL + GHR + GR + GSA + GAC + GMA + GT + GHT$$

(here, howling margin HM and amount of return RL, when the gain is set, are initially determined according to requirements, to make howling margin HM 6 dB and amount of return RL -2 dB, for example, and are treated as known values).

[0016]

An appropriate sum for amount of attenuation GTX in the transmission signal path and amount of attenuation GRX in the reception signal path can be found by substituting GST and GAC obtained by measurement in the right side of the formula above. In this application example, the maximum and minimum amount of attenuation of GTX and GRX are determined based on this sum and requirements for reception gain and transmission gain as described above, and amount of attenuation GTX of transmission signal variable attenuator 13 and amount of attenuation GRX of reception signal variable attenuator 19 are controlled according to the transmission, reception or other mode. With this invention, the sum GTX + GRX of the amount of attenuation of transmission signal variable attenuator 13 and the amount of attenuation of reception signal variable attenuator 19 are determined from the amount of line coupling and the amount of acoustic coupling measured in the actual usage environment of the device and the desired howling margin and amount of return as described above, so the change in the amount of attenuation of the transmission or reception variable attenuator will not be greater than necessary, and natural conversation in which the beginning or end of speech is not readily cut off can be realized, as much as possible. The details in the measurement methods for the amount of line coupling and the amount of acoustic coupling are as below. In this embodiment, in concrete terms, the amount of line and acoustic coupling is calculated from the ratio of the "signal magnitude" at 2 points in the circuit.

[0017]

(1) Line coupling measurement

A signal is output to point B in the circuit, the "signal magnitude" at point B and point C is found, and (signal magnitude at point C) / (signal magnitude at point B) = R' is found. Assuming that the amount of attenuation in the circuit from point B to hybrid transformer 5, and from hybrid transformer 5 to point C can be ignored, line coupling amount R is defined as aforementioned attenuation rate R' in the circuit in hybrid transformer 5, that is, the line part. Here, the amount of line coupling, when indicated by level, is represented with $20\log_{10}R'$ (unit: dB), so when indicated by level, will be line coupling amount R = (signal level at point C) – (signal level at point B).

(2) Acoustic coupling measurement

A signal is output to point D in the circuit, "signal magnitude" at point D and point A is found, and attenuation rate r' in the path speaker amp 17 → acoustic space from speaker 3 to microphone 2 → microphone amp 11 is found with (signal magnitude at point A) / (signal magnitude at point D) = r'. Acoustic coupling amount r is the attenuation rate in the acoustic space from speaker 3 to microphone 2. The amount of acoustic coupling, when indicated by level, is represented with $20\log_{10}r'$ (unit: dB), and when indication by level is used, it can be measured with acoustic coupling amount r = (signal level at point A) – (signal level at point D) – (speaker amp amplification rate level) – (microphone amp amplification level).

[0018]

The automatic measurement of the amount of line coupling and the amount of circuit coupling, and the following determination of the sum of the amount of attenuation of transmission signal variable attenuator 13 and the amount of attenuation of reception signal variable attenuator 19 as described above are performed when power is turned on. In this application example, control part 21 determines by sensing at point A and point C (refer to Figure 1) in order to recognize such a state. Here, the timing, in addition, may also be at any time when power is on and a call has not yet been made, that is, no audio signals produced by conversation have been transmitted to either transmission signal path 9 or reception signal path 15, such as at a time designated by the user pressing an initial setting button, for example.

[0019]

As the method of measuring the magnitude of signals, as mentioned above, the following means are conceivable.

1) Effective value at a certain time interval (100 ms, for example)

2) Output value when signal is input to a certain specific number of filters.

Such processing is effective for measuring reliably, since signals with acute variation, such as noise and voice signals, are used. Concerning timing,

a) Measuring with the same timing at 2 observation points.

b) Taking into consideration time lag to propagate in the circuit or space.

a) has the advantage that processing is easy, and b) has the advantage that while processing is complicated, more accurate coupling amounts can be measured. Here, the lag time of signals entering reception signal path 15 caused by line coupling is extremely small and constant, but the lag time of signals entering transmission signal path 9 due to acoustic coupling always varies according to the variable environment, e.g., a person being nearby, so in order to perform b) accurately, it is necessary to sense lag time constantly. Here, to consider applying such time

sensing to an actual speakerphone configuration, when noise or a pure tone is used, for example, realization is difficult. When an audio signal is used, it is important to note that an extremely tiny, complicated circuit is necessary to mark the peak of the signal.

[0020]

The signal used for measurement of the amount of coupling, in addition to the white noise above, may also be a signal that includes a frequency component required for the calling transmission band, band noise, or a pure tone, for example (the advantages of each are described below). An application example of the present invention was explained above. The distinctive points in the constitution of the above application example follow. A line coupling amount measurement means that measures the amount of line coupling from the aforementioned transmission signal path through the aforementioned line part to the aforementioned reception signal path is composed of the aforementioned line coupling meter 37, and an acoustic coupling amount measurement means that measures the amount of acoustic coupling from the speaker to the microphone in the environment where the aforementioned speaker and microphone are installed is composed of aforementioned acoustic coupling meter 35. A gain setting means that sets the sum of the amount of attenuation of the aforementioned transmission signal variable attenuator and the amount of attenuation of the aforementioned reception signal variable attenuator based on the measured output of the aforementioned line coupling amount measurement means and the measured output of the aforementioned acoustic coupling amount measurement means that transmits said setting value to the aforementioned control means at a point when no call has been started is composed of aforementioned control part 21.

[0021]

Effect of the invention

As explained above, with the loudspeaking telephone device pertaining to the present invention, the amount of line coupling and the amount of acoustic coupling are automatically measured by outputting signals from signal generators to the transmission signal path and the reception signal path, and the sum of the amount of attenuation of the transmission signal variable attenuator and the amount of attenuation of the reception signal variable attenuator is set using the amount of line coupling and the amount of acoustic coupling measured in the actual usage environment of the loudspeaking telephone device. Thus, the amount of attenuation can be set according to the usage environment to obtain the desired howling margin, without the sum of the amount of attenuation of the transmission variable attenuator and the reception variable attenuator being set greater. Therefore, the amount of attenuation when switching between transmission and reception will be relatively small, cutting off at the beginning or end of speech does not readily

occur, and natural conversation can be achieved. Furthermore, measurement of the amount of acoustic coupling and the amount of line coupling, and setting of the sum of the amount of attenuation of the transmission variable attenuator and the reception variable attenuator corresponding to that, are performed with appropriate timing when a call has not yet started, so complex processing to constantly measure the amount of acoustic coupling and the amount of line coupling during a call and change the amount of attenuation during the call accordingly is not needed, the circuit configuration is simplified, the amount of calculation can be decreased, and the assembly costs of the device can be made inexpensive. Unique effects for each are achieved by deciding on the type of signal generated from the signal generators as below. For example, the following advantages exist with signals that comprise a frequency component necessary for the call transmission band. Acoustic coupling can be obtained from the start of transmission within the telephone line and output by the speaker, and in a frequency range that can be output by the microphone. It is set to match the telephone transmission frequency band, and the reception signal that reaches it through the telephone line is composed of frequency components transmitted by the telephone, so acoustic coupling in signals with such frequency components must be measured. Measurement adapted to the actual usage circumstances is achieved by using signals that basically comprise the frequency components transmitted by the telephone, for example, a telephone ring tone, call confirmation tone, or synthesized voice (such as help, e.g., "starting speakerphone operation)."

[0022]

The following advantages below exist by using band noise, for example, for measurement. For example, when it is expected that the loudspeaking telephone device will be used in an environment with loud background noise, by using band noise limited to the frequency band (for example, a central frequency of 1 kHz or 2 kHz) in which the S/N ratio (signal to noise ratio) is expected to be greater (generally, the low-frequency components of ambient noise, such as air conditioner fan noise, are louder, and the frequency components of voice from 1 kHz to 3 kHz are louder, so the S/N ratio is often smaller at the lower frequencies and becomes larger from 1 kHz to 3 kHz), the magnitude of the signals generated can be made smaller. That is, the sound coming from the near-side talker's speaker can be made smaller when acoustic coupling is measured, and the sound coming from the far-end talker's speaker can be made smaller when line coupling is measured. The signal generator configuration can be made simpler by using white noise for measurement, and furthermore, the frequency components necessary to measure line coupling and acoustic coupling are all included in white noise, so the aforementioned amount of attenuation can be controlled correctly without sacrificing measurement precision. The signal generator configuration can be simplified even more than with the signals above by using a pure tone for

measurement. Especially when LSI is used for the line part, for example, the hybrid transformer (2 wire – 4 wire converter), the amount of line coupling is nearly constant independent of frequency, so values sufficiently accurate for practical use are obtained with the amount of line coupling measured using an easy-to-generate pure tone (sine wave with a single frequency). With the above, the amount of attenuation of the transmission signal and the reception signal can be set correctly and easily corresponding to the amount of line coupling produced by the connection state to the line, and with the amount of acoustic coupling produced by the installation environment and usage circumstances, and a loudspeaking telephone device can be provided with which reliable conversation is performed without diminished naturalness.

Brief description of the figures

Figure 1 is a block diagram showing the constitution of a speakerphone pertaining to an application example of the present invention.

Figure 2 is a circuit diagram showing the configuration of a conventional hands-free circuit.

Figure 3 is a circuit diagram showing the configuration of a conventional hands-free circuit.

Explanation of symbols

1	Speakerphone
2	Microphone
3	Speaker
5	Hybrid transformer (line interface part)
9	Transmission signal path
11	Microphone amp
13	Transmission signal attenuator
15	Reception signal path
17	Speaker amp
19	Reception signal variable attenuator
21	Control part
23	Transmission side voice to noise sensor
25	Reception side voice to noise sensor
27, 29	Level comparator
31, 33	Signal generator
35	Acoustic coupling meter
37	Line coupling meter

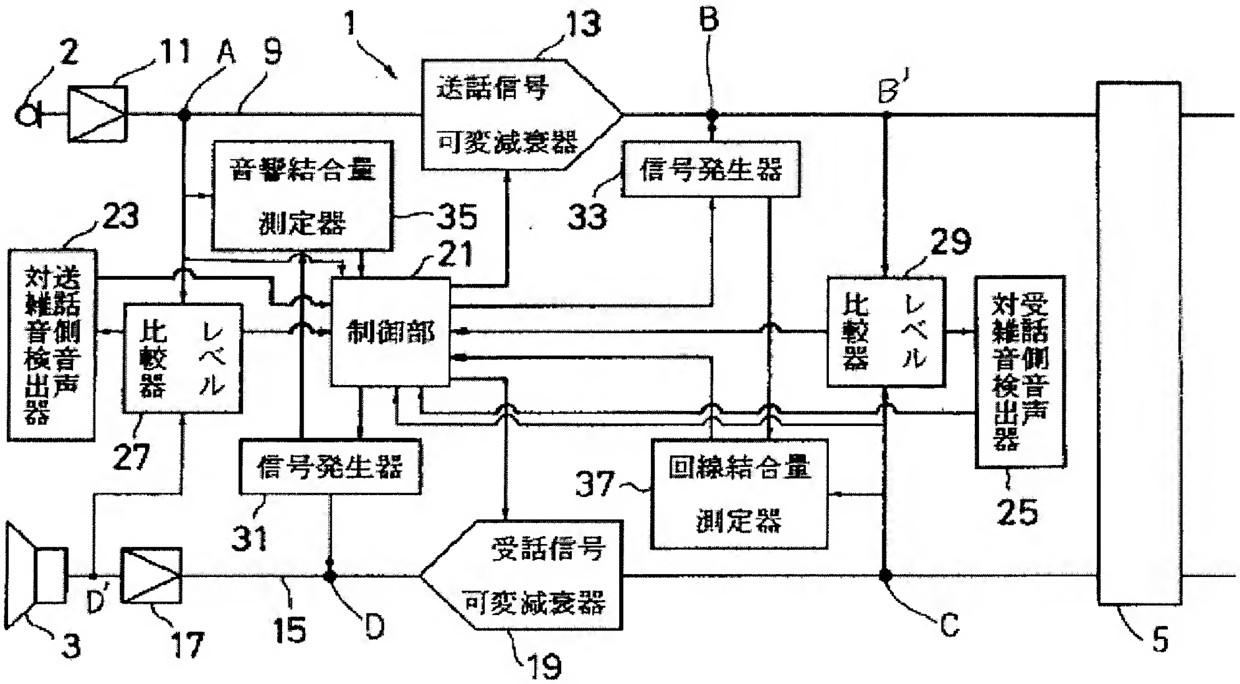


Figure 1

Key:
13 Transmission signal variable attenuator
19 Reception signal variable attenuator
21 Control part
23 Transmission side voice to noise sensor
25 Reception side voice to noise sensor
27 Level comparator
29 Level comparator
31 Signal generator
33 Signal generator
35 Acoustic coupling meter
37 Line coupling meter

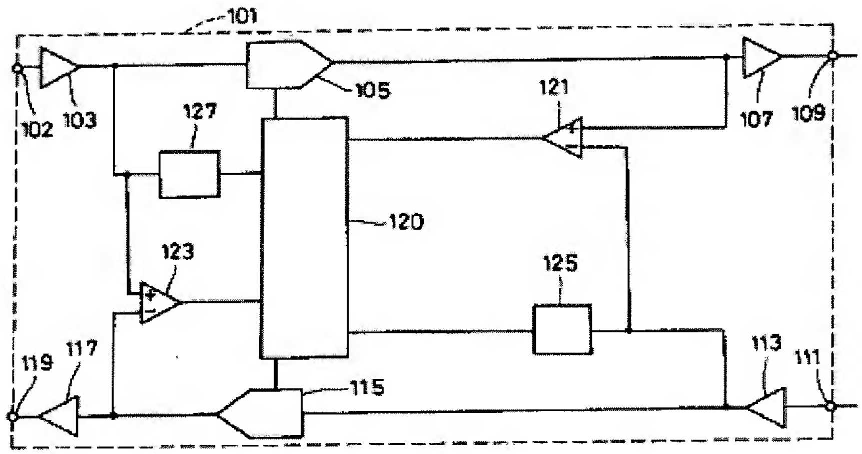


Figure 2

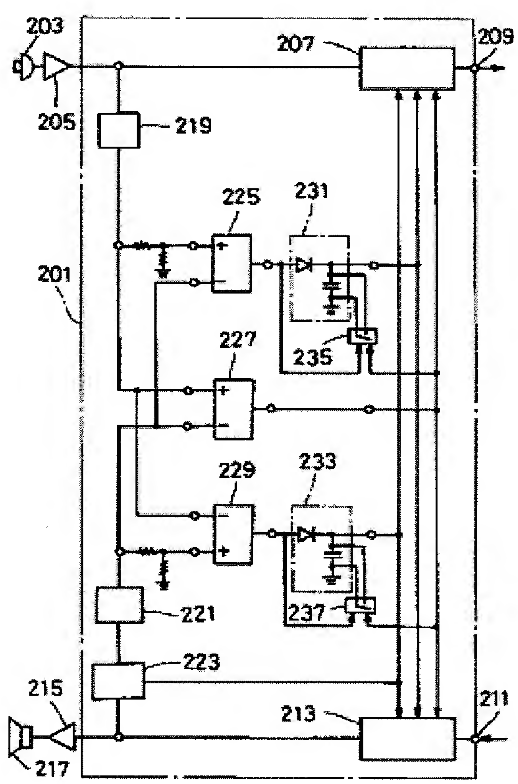


Figure 3